Ontario. Ministry of the Environment

Air quality studies in the vicinity of the Secondary Treatment System, Boise Cascade Canada Limited, Fort Frances.

1982

AIR QUALITY STUDIES
in the vicinity of the
SECONDARY TREATMENT SYSTEM,
BOISE CASCADE CANADA LIMITED, FORT FRANCES

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INTRODUCTION

The pulp and paper manufacturing facility operated by Boise Cascade Canada Limited in Fort Frances includes a 500 ton-per-day kraft pulp mill. Liquid effluent from this mill is piped to a secondary treatment system, which consists of two settling basins and an aeration pond. Treated wastes from the system are discharged to Rainy River.

In response to a vegetation injury complaint received from a vicinity resident in the spring of 1980, the Ministry began an investigation in the area on the south side of the aeration pond. Vegetation and soil samples were collected for chemical analysis and a moss exposure experiment was conducted. Cores from injured tree stems were also obtained and groundwater was sampled from existing test wells around the perimeter of the treatment system. In early 1981, a snow sampling survey was undertaken, and additional vegetation, soil, and groundwater studies were carried out during the 1981 growing season.

VEGETATION ASSESSMENT

In the course of several visits during the 1980 growing season, significant foliar damage was observed on several kinds of trees on the south side of the treatment system, both on and off company property. On privately owned land on the south side of Eighth Street, injury was conspicuous on red pine, white spruce and Manitoba maple. The owner claimed that first effects were noticeable in 1974 when he purchased the land.

Chemical analysis showed that, compared to control samples, chloride was significantly elevated, sodium was moderately elevated and sulphur was not elevated in injured foliage (Table 1). Very high chloride concentrations were found in both current and 1-year-old coniferous foliage. Chloride levels in tree foliage near the aeration pond, but off company property, were 6 to 35

times higher than chloride in control samples. Chloride and sodium concentrations decreased as distance from the south end of the pond increased.

Cores of stemwood from damaged red pine and white spruce on private property to the south of the pond indicated that the diameter growth rate of trees in this area had declined in recent years, particularly after 1976.

Foliage from trees on the south side of the pond was re-sampled in August, 1981. Many of the trees recorded as severely damaged in 1980 had been felled and removed. No new injury was observed among the remaining trees. Samples of willow, black ash, Manitoba maple and white spruce foliage showed significant declines in concentrations of both chloride and sodium, compared to the values found in 1980, at sites nearest the pond (Table 2).

Examination of broadleaved vegetation (willows, trembling aspen, balsam poplar and fireweed) around the northern end of the treatment system in 1981 showed evidence of foliar injury similar to that documented at the opposite end of the lagoon in 1980. About half the damage was on company property, with the remainder on land owned by the Town of Fort Frances to the north and east (Figure 2). The total area affected was approximately 11 hectares. Injury symptoms on willow and fireweed foliage at sites 1, 2 and 3 (Figure 2) appeared as severe marginal necrosis. Severe marginal and interveinal necrosis on balsam poplar and severe marginal necrosis of trembling aspen foliage was also observed at site 5. A slight browning of balsam poplar and trembling aspen leaves was noted at sites 4 and 6 but no necrosis was evident. The results of chemical analysis of samples from this area are reported in Table 3. Chloride and sodium concentrations were extremely high in willow and fireweed in the injury zone, but only moderately elevated in trembling aspen and balsam poplar.

MOSS EXPOSURE EXPERIMENT

Samples of Sphagnum moss exposed in July, 1980 at several sites (Figure 3) revealed that airborne chloride was significantly above normal and sodium very slightly above normal. Calcium and sulphur were not elevated. Road dust from Eighth Street might have contributed to the chloride and sodium values in moss. Moss samples were again exposed at the same locations during August, 1981. Concentrations of chloride and sodium were found to be at or near normal levels, as shown in Table 4.

SNOW SAMPLING

Snow cores were collected in February, 1981, from several locations to the south and southeast of the treatment system. Of the several possible contaminants analyzed, only sulphate was slightly above normal levels. There was no evidence that airborne pollutants from the treatment system had been deposited in the surrounding area during winter months preceding the date of the survey.

SOIL SAMPLING

In 1980, surface soil (0-10, 10-20 cm) sampled at three locations at the south end of the aeration pond showed that chloride or sodium concentrations were normal.

Samples were obtained from six levels, to a total depth of 90 cm, at four sites in the same area in August, 1981 (Figure 4). The chloride and sodium concentrations in these soils were also found to be normal (Table 5) and there were no concentration gradients of either element with increasing soil depth or site distance from the aeration pond.

GROUNDWATER ANALYSIS

Analysis of water collected in October, 1980, from seven Boise Cascade test wells around the perimeter of the treatment system suggested that general contaminants concentrations (expressed as conductivity) had increased since 1971, prior to treatment system start-up. This finding was, however, not considered to be evidence of soil contamination in the surrounding area.

The six company-owned test wells and six new Ministry wells off company property (Figure 5) were sampled in June, 1981. Results are compiled in Table 6. Levels of all parameters, except pH, were highest at station 13 and appeared to decrease with increasing distance from this site. The distribution pattern for sodium, in Figure 6, was similar to that for calcium, chloride, conductivity, alkalinity and hardness.

CONCLUSION

Injury to vegetation has been documented on the south side of the Boise Cascade secondary treatment sytem in 1980 and on the north and east sides in 1981. Chemical analysis has shown that damaged vegetation in all areas contained high concentrations of sodium and chloride and that the latter, in particular, was well above levels reported to cause visible injury. Foliar injury symptoms were similar to those described in the literature for excess chloride (1). Both the level of injury and contaminant concentrations declined sharply as distance from the aeration pond increased. Moss exposure experiments demonstrated that airborne chloride to the south of the pond was elevated in 1980 and normal in the late summer of 1981. Snow sampling indicated that contaminant dispersion did not occur during winter.

There was no evidence of elevated chloride or sodium in soil, even at depths of 90 cm. The quality of groundwater in the immediate vicinity of the secondary treatment system may have

declined in the decade since the system became operational, but this modest change was not responsible for any of the documented vegetation effects. Road salt, climatic conditions and insect and disease involvement were all carefully considered and ruled out as significant contributors to the effects observed.

The evidence from our investigation implicated windborne spray from spray guns around the perimeter of the aeration pond as the cause of vegetation damage. In 1980, when the guns were operated at the south end of the pond, vegetation injury was confined to that area. In 1981, the guns were moved to the north end, and damage then appeared in that area, with a concomittant decline in visible injury and contaminant levels in vegetation which had been damaged in 1980 near the south end.

ABATEMENT ACTION

The continued operation of the spray guns around the aeration pond perimeter is liable to result in further vegetation damage. Most of the effect will be absorbed on company property, but some off-property damage can be expected. It is recognized, however, that the spray guns play a significant role in foam control and that this benefit outweighs the modest damage to nearby vegetation. Future improvements in effluent treatment, scheduled in the existing Ministry Control Order, may eventually permit a reduction in the use of spray guns for foam suppression.

REFERENCES

1. Lumis, G. P., G. Hofstra and R. Hall, 1971. Salt damage to roadside plants. Ministry of Agriculture and Food.

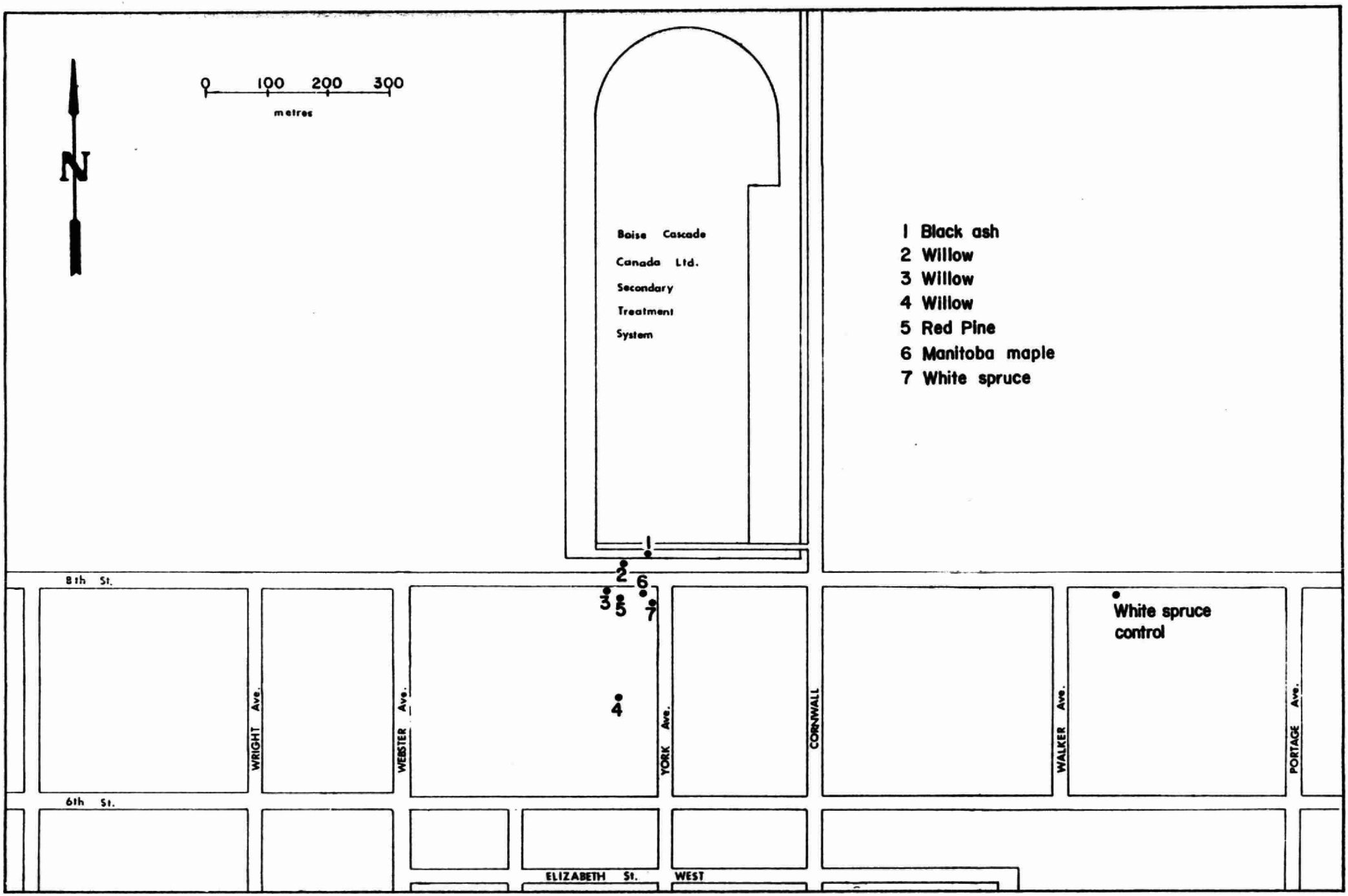

Figure 1. Tree foliage sampling sites, south end of lagoon, Fort Frances, August, 1980.

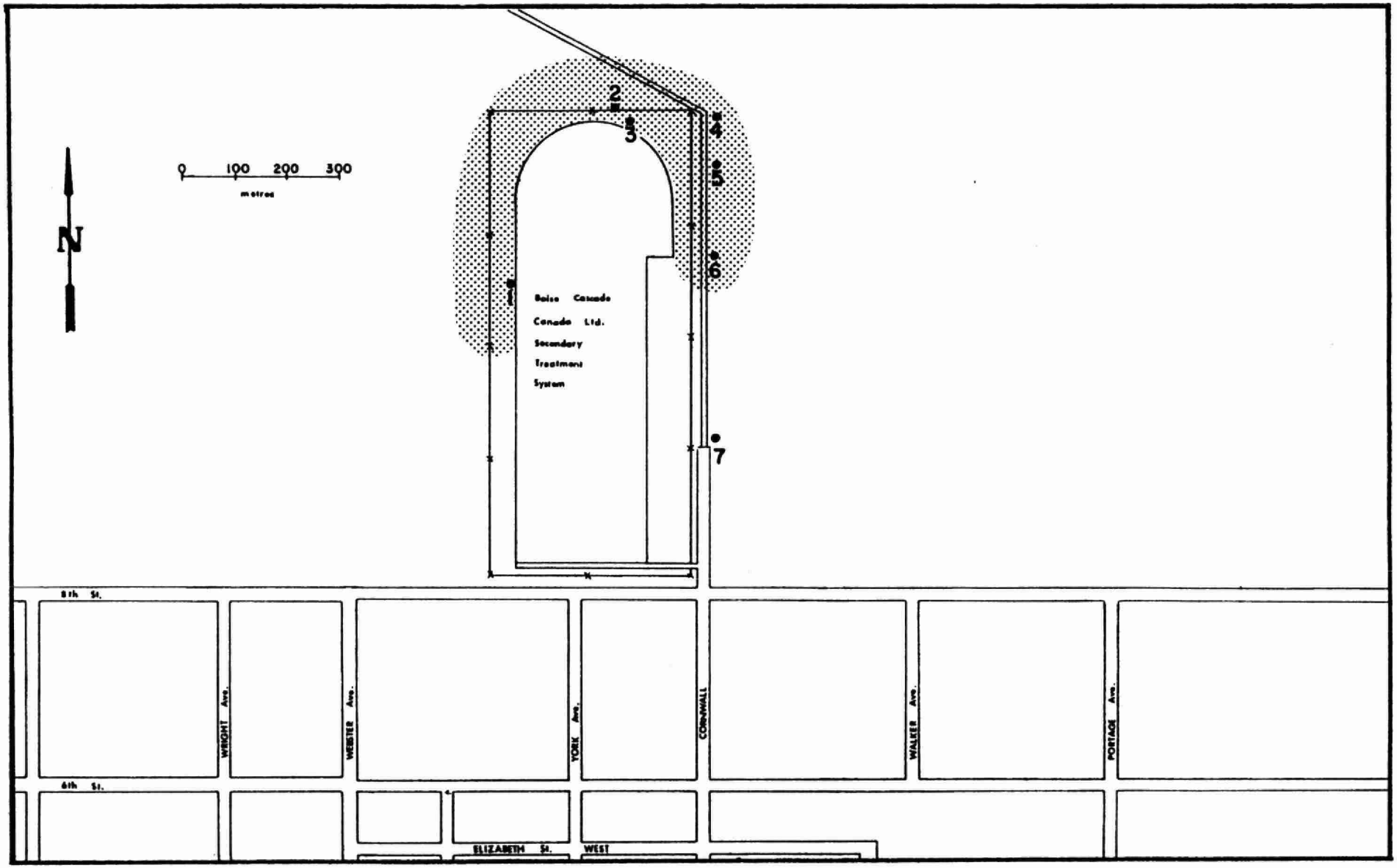

Figure 2. Vegetation sampling sites, north end of lagoon, August 6, 1981.

Vegetation injury zone

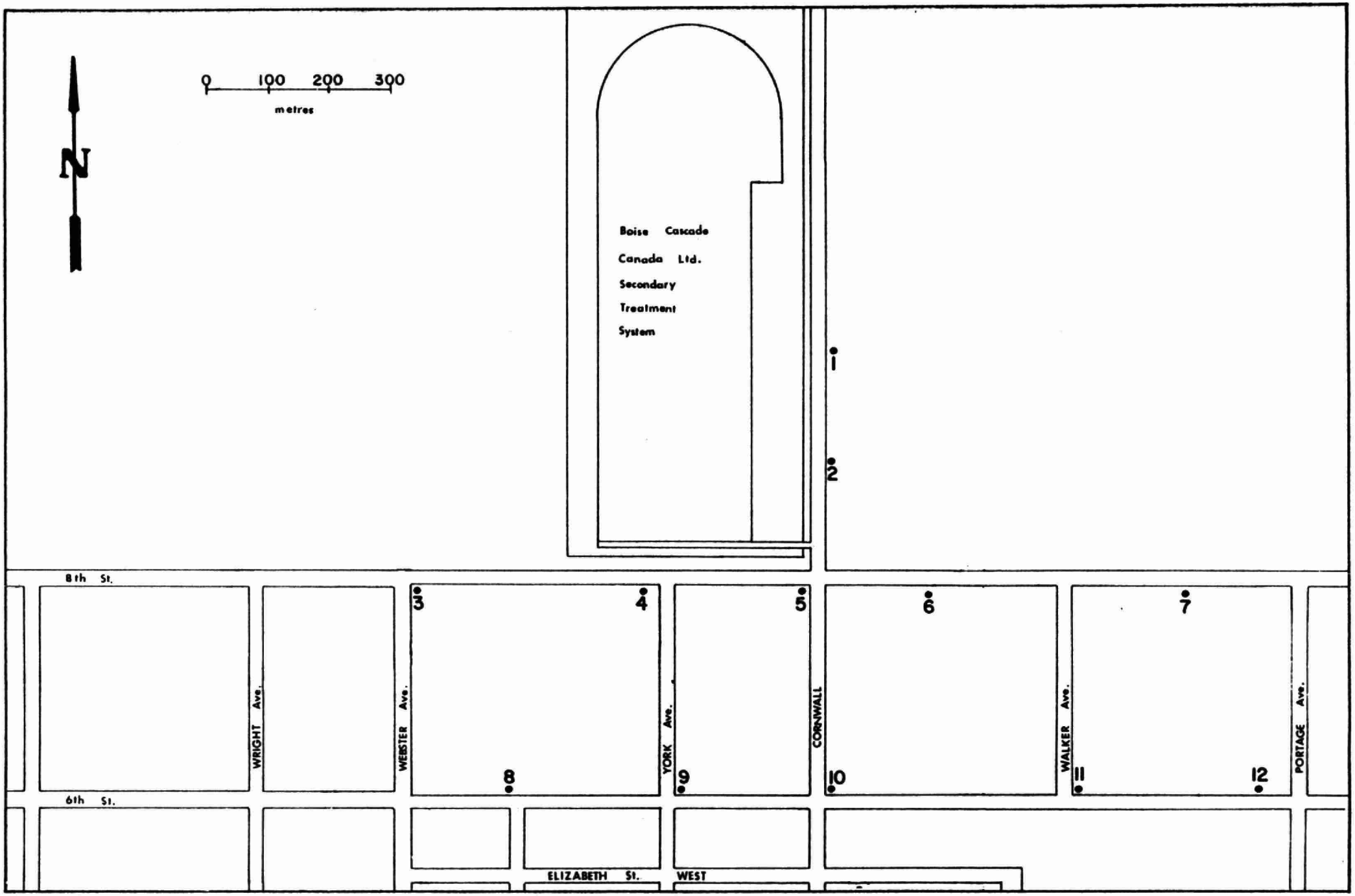

Figure 3. Sphagnum moss bag exposure sites, Fort Frances, 1980 and 1981.

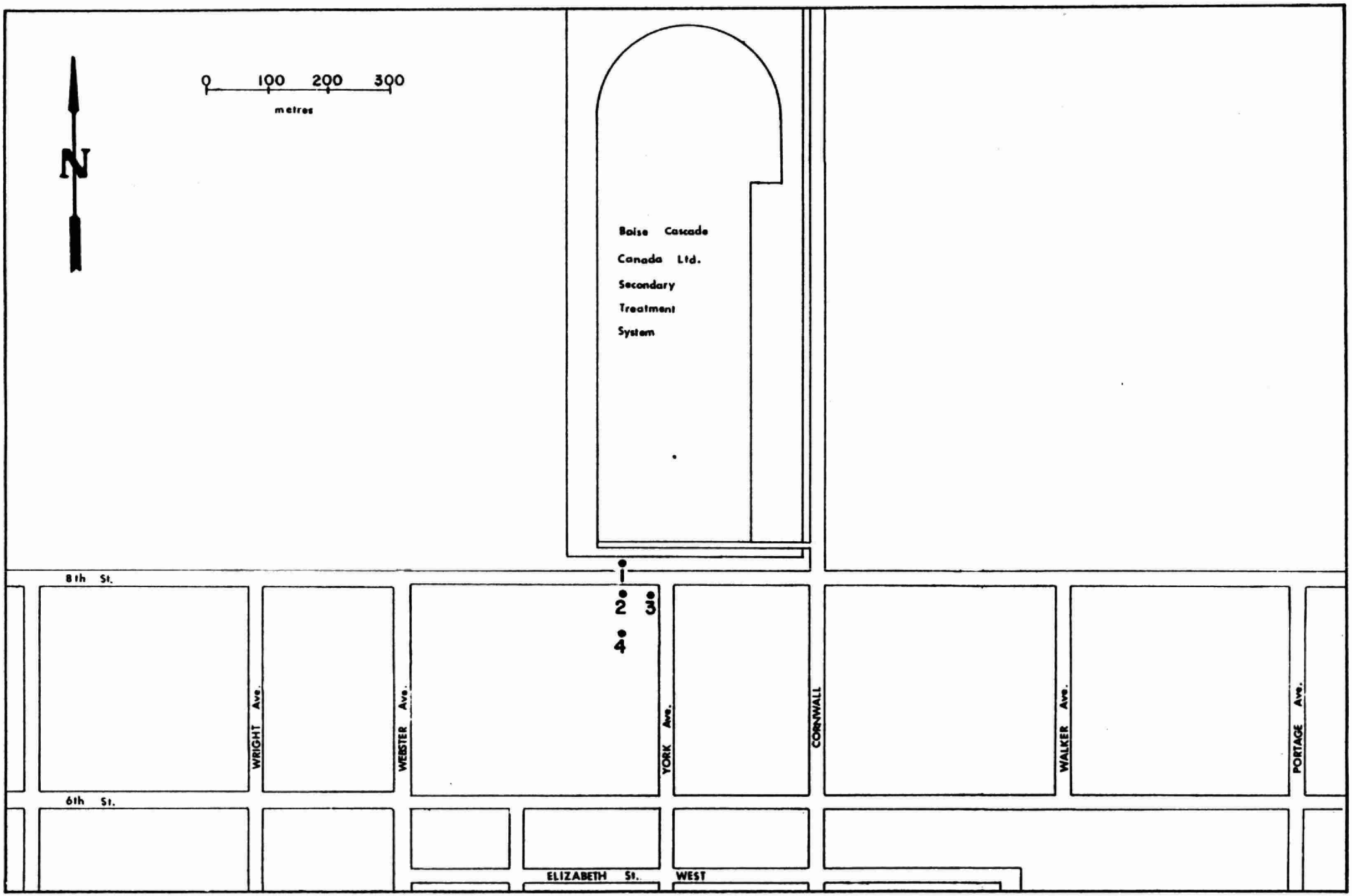

Figure 4. Soil sampling sites, Fort Frances, August 6, 1981.

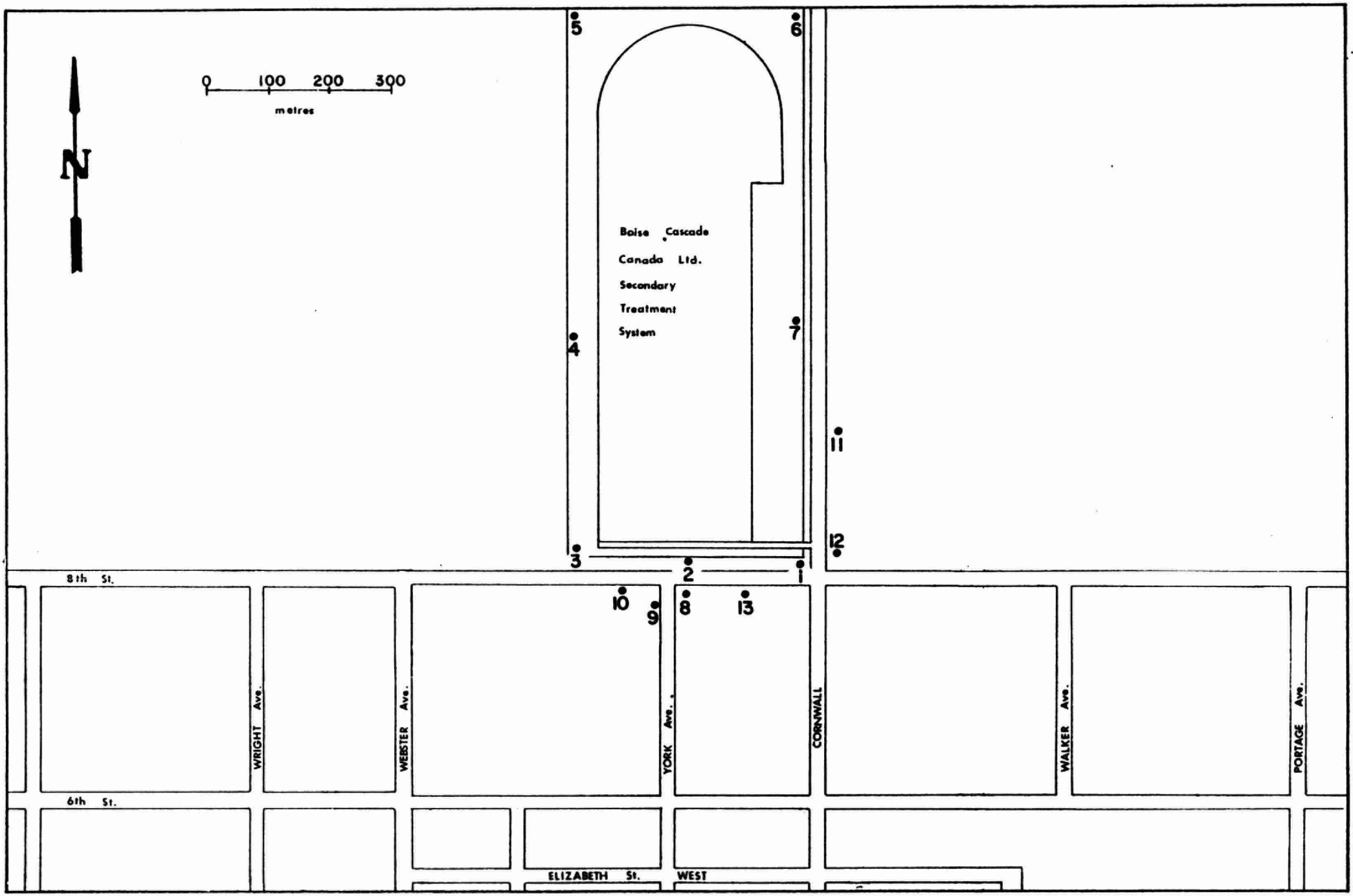

Figure 5. Ground water sampling sites, Fort Frances, June 3-4, 1981.

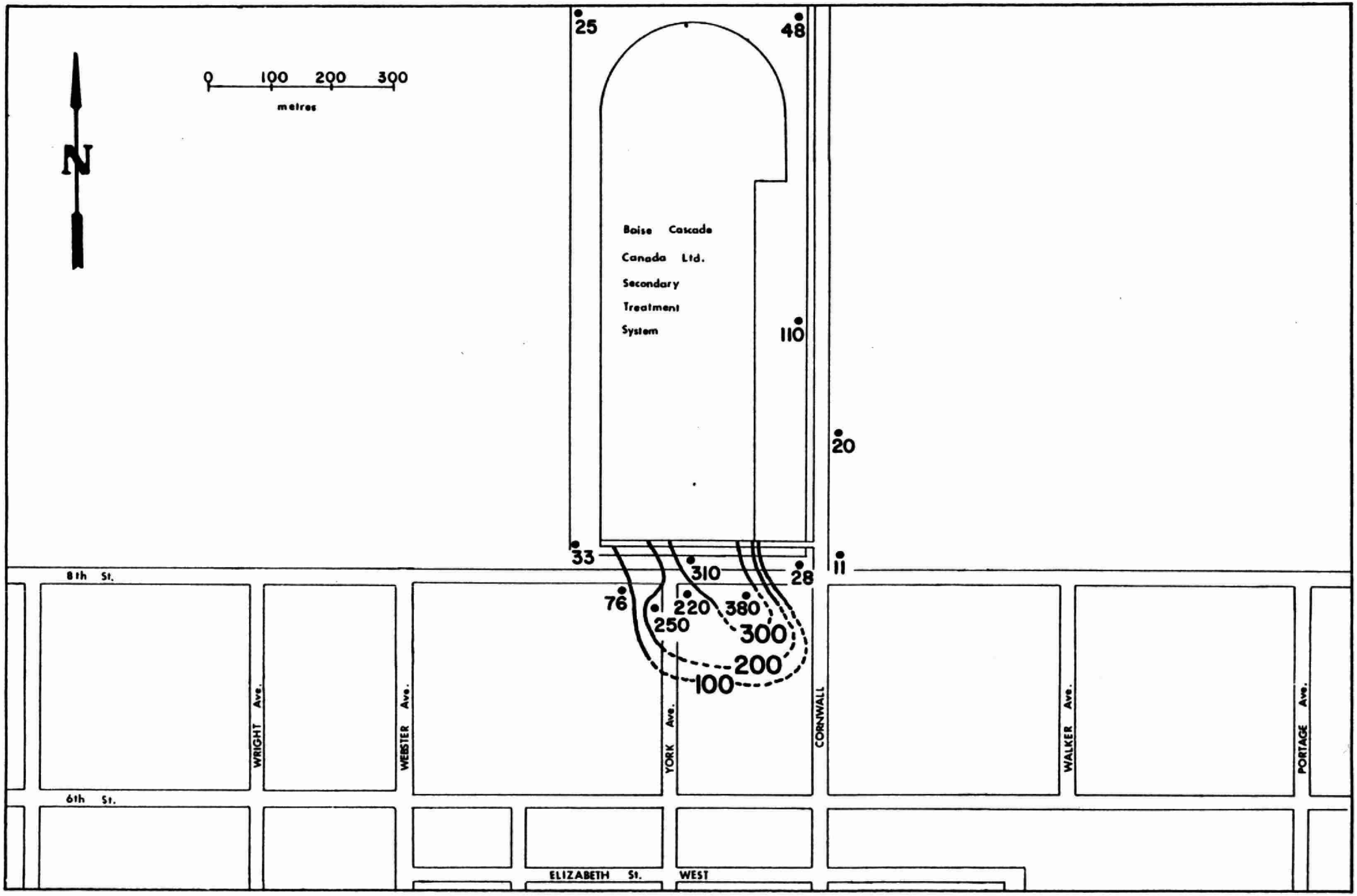

Figure 6. Levels of sodium (mg/l) in ground water, Fort Frances, June 3-4, 1981.

TABLE 1. Levels of chloride, sodium, and sulphur (µg/g, dry weight) in tree foliage sampled in July, 1980, on the south side of the Boise Cascade secondary treatment system, Fort Frances.

Foliage sampled	Location	Chloride	Sodium	Sulphur
Red pine	Site 5[a]	4200	52	1000
(current foliage)	Control	300	<1	700
Red pine	Site 5	6200	270	1100
(1-year-old foliage)	Control	600	96	700
White spruce	Site 7	8700	44	800
(current foliage)	Control	1400	11	500
White spruce	Site 7	12000	140	900
(1-year-old foliage)	Control	1200	20	800
Manitoba maple	Site 6	12000	840	2300
	Control	2600	53	2000
Black ash	Site 1	21000	8700	2700
	Control	600	6	2300
Willow	Site 2	6500	1300	4000
	Site 3	8900	1200	3200
	Site 4	700	36	2900
	Control	400	8	6100

[a]Sampling sites are shown on Figure 1.

TABLE 2. Levels of chloride and sodium (µg/g, dry weight) in foliage sampled on July 3, 1980 and August 6, 1981 in the vicinity of the Boise Cascade secondary treatment system, Fort Frances.

Foliage sampled	Location	Chloride		Sodium	
		1980	1981	1980	1981
Willow	Site 2[a]	6500	1000	1300	59
"	Site 3	8900	3000	1200	190
"	Site 4	700	1000	36	25
"	Control	400	1000	8	34
Black ash	Site 2	21000	1000	8700	82
" "	Control	600	2000	6	21
Manitoba maple	Site 6	12000	8000	840	64
Manitoba maple	Control	2600	6000	53	84
White spruce (current foliage)	Site 7	8700	5000	44	35
	Control	1400	3000	11	29
White spruce (1-year-old foliage)	Site 7	12000	6000	140	41
	Control	1200	2500	20	45

[a]Sampling sites shown on Figure 1.

TABLE 3. Concentrations of chloride and sodium (µg/g, dry weight) in vegetation sampled on August 6, 1981, at the north end of the Boise Cascade secondary treatment system, Fort Frances.

Sample	Location	Chloride	Sodium
Willow	1[a]	15000	6300
	2	18000	6500
	Control	1000	34
Fireweed	3	19000	6500
	Control	4000	86
Trembling aspen	4	5600	910
	5	4900	880
	6	3300	300
	7	4200	200
	Control	5000	22
Balsam poplar	4	4800	1700
	5	7900	3200
	6	2500	670
	7	1800	200
	Control	2000	81

[a]Sampling sites shown in Figure 2.

TABLE 4. Levels of chloride and sodium (µg/g, dry weight) in sphagnum moss exposed July 3 to August 5, 1980 and August 5 to September 3, 1981.

Site[a]	Chloride		Sodium	
	1980	1981	1980	1981
1	700	500	290	250
2	300	200	180	400
3	1400	200	290	300
4	1500	800	480	420
5	1700	600	390	400
6	1400	500	280	360
7	1100	700	280	290
8	200	600	120	420
9	300	300	140	360
10	400	300	140	280
11	700	500	190	300
12	500	400	270	320
Exposed control	400	400	180	310
Unexposed control	400	400	100	200

[a]Sampling sites shown in Figure 3.

TABLE 5. Concentrations of chloride and sodium (µg/g, dry weight) in soil sampled on August 6, 1981, on the south side of the Boise Cascade secondary treatment system, Fort Frances.

Soil Depth(cm)	Sites[a] 1		2		3		4	
	Chloride	Sodium	Chloride	Sodium	Chloride	Sodium	Chloride	Sodium
0 - 15	100	260	<100	210	400	510	-	160
16 - 30	200	390	<100	100	<100	160	<100	97
31 - 45	<100	140	<100	170	100	330	<100	87
46 - 60	<100	160	-	100	200	270	<100	170
61 - 75	<100	110	<100	100	-	210	<100	99
76 - 90	<100	110	200	91	<100	120	<100	85

[a]Sampling sites shown in Figure 4.

TABLE 6. Chemistry of groundwater from test wells sampled on June 3-4, 1981, in the vicinity of the Boise Cascade secondary treatment system, Fort Frances.

Site[a]	Calcium mg/ℓ	Chloride mg/ℓ	Sodium mg/ℓ	Sulphate mg/ℓ	Conductivity µmhos/cm	Alkalinity mg/ℓ as $CaCO_3$	Hardness mg/ℓ as $CaCO_3$	pH
1	250	37	28	-	1100	-	770	6.7
2	4	2	310	11	1100	480	180	7.5
3	240	260	33	85	1700	430	860	6.6
5	100	1	25	22	700	380	380	6.6
6	260	200	48	53	1600	600	780	6.7
7	230	250	110	52	1800	580	670	6.7
8	220	420	220	17	2200	630	700	6.6
9	270	510	250	15	2700	700	880	6.6
10	100	200	76	29	1100	220	340	6.7
11	160	30	20	39	1000	510	540	6.8
12	140	8	11	15	810	430	440	6.7
13	360	820	380	-	3600	1200	1200	6.7
Drinking water quality objective	<200	<250	<50	<250	<900	-	<250	6.0-8.5

[a]Sampling sites shown on Figure 5.

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